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A New Explanation for Samuelson's Dictum and the Stock Market: Novel Events and Knightian Uncertainty

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Samuelson's Dictum argues that aggregate stock markets do not convincingly reflect information on fundamentals, such as dividends or earnings, and are, thus, inefficient in setting prices. By contrast, firm-level stock prices share a much closer connection with fundamentals and are, therefore, deemed relatively efficient. This paper presents an alternative explanation: Knightian uncertainty stemming from historically unique events produces differential impacts on investor forecasting bounds at the aggregate versus firm level. Several uncertainty proxies are employed from millions of unscheduled events identified in the universe of Dow Jones & Co. financial news reports over the last twenty years. Uncertainty based on count and proportion of unscheduled events shares a significant inverse relationship with the range of forecasting bounds on returns and earnings at both the aggregate and firm level suggesting informational effects may dominate. However, when uncertainty is measured based on the diversity of unscheduled event groups, the forecasting bounds for broad stock market returns widen, while those at the firm level narrow, implying model ambiguity dominates at the aggregate level. These findings are robust for the majority of Dow Jones Industrial Average 30 firms and for alternative categories of unscheduled events.

Keywords: stock market, novel events, Samuelson's Dictum, Knightian uncertainty

JEL Codes: G12, G14, D80, D84

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I. Introduction

Samuelson's dictum asserts that stock markets are "micro efficient," yet "macro inefficient," reflecting a closer connection between prices and fundamentals, such as dividends or earnings, for individual firms than at the aggregate level.¹ Many studies using aggregate data have addressed this topic using Campbell and Shiller (1988)'s log-linearized present value model decomposing variation of price ratios into dividend-growth, so-called "rational bubbles," and expected returns.² The majority of findings conclude that broad market behavior is better explained through expected returns and time-varying risk premia than through cash flow dynamics.³ By contrast, when firm-level data is applied, dividend properties and other measures of cash flow dynamics become relatively more important in describing movements in stock prices.⁴ Jung and Shiller (2005), for example, investigate Samuelson's Dictum by running simple Gordon Growth-based regressions for all individual CRSP-listed firms dating back to 1926, finding significant predictive ability of price-dividend ratios on subsequent dividend growth; when firm data is aggregated into the broad market index, however, the coefficient on dividend growth is of the wrong sign and insignificant.

Samuelson (1998) and the supporting literature have offered the explanation that, unlike the "long waves" of "persistent" departures from "fundamental values" at the market level, firm level mis-pricing, or "aberrations," are quickly identified and arbitrated away by those traders tracking the minutiae of market responses to day-to-day corporate news events. That is, idiosyncratic risk is easier to identify. Consequently, many researchers have been divided, or self-selected, into efficient markets versus behavioral camps which view Samuelson's Dictum, respectively, as evidence that broad market indices are either, (i) driven by a time-varying risk premium underpinning variation in expected returns (Cochrane, 2017) or (ii) by persistent

¹ For background on Samuelson's Dictum, see, for example, Choi *et al.* (2019), Jung and Shiller (2005), Shiller (2001) and references therein.

² For a survey of this literature, see Cochrane (2011) and references therein.

³ Of course, the seminal study of Shiller (1981) triggered volumes of studies in this area after concluding that *ex post* dividends are not volatile enough to explain the variation in present value of prices for the aggregate stock market.

⁴ A non-exhaustive list of studies on cash flows versus discount rate effects on stock returns at the aggregate and firm level includes Campbell (1991), Cochrane (2001,1992), Vuolteenaho (2002), Campbell and Vuolteenaho (2004), Hecht and Vuolteenaho (2006), Kothari *et al.* (2006), Chen and Zhao (2009), Campbell *et al.* (2010), Koubouros *et al.* (2010), Engsted *et al.* (2012), Chen *et al.* (2013), and Campbell *et al.* (2018).

variation in market irrationality, fads, and various psychological and momentum-related factors exogenous to the marketplace (Barberis, 2018).

The present paper offers an alternative, hitherto unexplored, explanation for the results consistent with Samuelson's Dictum, one which does not rely on time-varying risk premia or investor irrationality. The hypothesis centers on the inherent role of uncertainty in a Knightian sense (Knight, 1921) which manifests itself in distinguishing ways for investor return forecasts at the aggregate versus firm level. Once framed under Knightian uncertainty (henceforth KU) and the differential effects, Samuelson's Dictum becomes an unsurprising result, one consistent with investor rationality and the limits of knowability facing all market participants.

Equity markets are inundated daily with news about unscheduled, or historically unique, events which cause unforeseeable change in stock price relationships and, therefore, produce investor uncertainty about the process driving outcomes.⁵ Macro unscheduled events such as trade wars, new tax policy, Central Bank announcements, or armed conflicts cause ambiguity about which model best describes stock prices relationships.⁶ However, it is often the case that numerous macro KU events unfold concurrently, exerting potentially conflicting views onto investor forecasts of returns – think, for example, the COVID-19 pandemic, historic Congressional stimulus, political instability and clusters of technological advancements characterizing 2020. The potentially conflicting macro noise and swirling uncertainty cause ambiguity about which available forecasting model (and those yet to be developed) may be best suited for assessing the impacts from such events on future outcomes. Thus, the prevalence of macro KU events tends to obfuscate broad market price forecasts at the aggregate level, widening the bounds of investor expectations.

Alternatively, micro unscheduled events such as management shake-ups, labor strikes, bankruptcies, data breaches, new products, and unfolding IPOs cause informational, as opposed to

⁵ See, for example, Mangee and Goldberg (2020). For a survey of structural change in asset markets, see Ang and Timmermann (2012).

⁶ The large literature on ambiguity aversion typically argues, first, that ambiguity refers to a “poor quality” of information signals and, second, that aversion to it implies preference formation that places individuals at particular points or segments within forecast/decision intervals. See, for example, Epstein and Schneider (2008). Here, ambiguity refers to true Knightian uncertainty which implies that no one knows which points on a forecasting interval correspond to the distribution describing outcomes. Ambiguity, here, reflects unknown distributions and the inability to formulate precise preference specifications *ex ante*.

ambiguity, effects which increase the confidence investors have in their forecasting strategies, whether bullish or bearish. Informational effects reflect fundamentals at the firm level for two reasons, both of which are connected to the spillover from macro KU events and the associated time-lag (Mangee, 2021). First, the uncertainty spillover from the aggregate to firm level necessarily involves some filtering of relevance for individual stock prices. A dramatic change in industry regulatory policy or a devastating hurricane in the gulf will naturally impact certain firm fundamentals more than others. Second, the time lag permits a more formulated and nuanced effect on fundamentals as rational psychology and narrative dynamics offer a degree of clarity and context in shaping investors' understanding (Frydman *et al.*, 2020; Mangee, 2018). Because there are often many interrelated factors upon which firm fundamentals are contingent, the time lag allows for the “net” effects to manifest themselves and become more apparent to the investor. A clearer “bullish” versus “bearish” picture emerges and the bounds of investor forecasting intervals narrow.

The importance of historical events for describing both aggregate and firm stock price behavior has been underestimated in the theoretical and empirical literature on asset market fluctuations and risk. Popular studies related to the underlying findings of Samuelson's Dictum have focused on time-varying rare disaster risk *a la* Barro (2006) or on representativeness and systematic investor over- and underreaction in behavioral settings (Gennaioli and Shleifer, 2018). However, the vast majority of these studies assume that the way investor expectations and, therefore, asset price relationships change over time (if they are allowed to do so) can be modeled with a stochastic process, such as a Markov-switching rule. Such modeling approaches preclude the unforeseeable change that KU events engender on stock market relationships.

Bordalo *et al.* (2018), for example, argue that individual market participants routinely overreact to macroeconomic and financial news while the consensus market systematically underreacts to new information. Similarly, Bordalo *et al.* (2019) model stock return expectations as mechanically determined by the history of earnings growth updated based on “objective likelihoods” of future return states. Such studies dismiss the effects of inherent instability and Knightian uncertainty on investor beliefs and the connection between price fluctuations and new information on KU events.

To model asset price fluctuations while allowing for unforeseeable change and uncertainty, Frydman *et al.* (2019) rely on an intervallic framework which bounds investor forecasts, coefficients, explanatory variables, and predicted outcomes. Coefficients on forecasting variables, for example, lie at an unknown point in time within some quantitative interval and are characterized by one of a family of unknown distributions. Over time, coefficients are allowed to change in open ways and reflect alternative unknown distributions within the forecasting bounds which themselves are characterized by *ex ante* stochastically determined constraints. Doing so, allows the Knightian Uncertainty Hypothesis (KUH) to maintain empirical relevance, model consistency and investor rationality while still allowing for unforeseeable change in the processes driving market outcomes. Within stochastically constrained intervals, conventional fundamentals, broader information, and investor psychology are allowed to influence investor expectations in myriad unforeseeable ways. That is, change in the model's posited relationships, say between stock prices and earnings, is partially determined at a point in time and left to unfold in conditionally open ways over time, affording an autonomous role for expectations and narrative dynamics.⁷

The present analysis extends the theoretical model of Frydman *et al.* (2019) to account for the informational versus model ambiguity effects of Knightian uncertainty on investor forecast bounds. The extension shows that different uncertainty effects due to historically unique events cause changes in the size of intervallic forecast bounds. In addition to a horizon effect which increases the forecasting bounds the further away the prediction is, there are also ambiguity and informational effects which manifest themselves in differential ways at the aggregate versus firm level. Model ambiguity reinforces the horizon effect while informational effects contradict it leading to potentially narrower forecasting bounds. Confronting Samuelson's Dictum within the KUH framework with empirical analysis requires data on both stock market uncertainty and investor forecasts of future outcomes, such as earnings and returns. This paper provides data on both realms of considerations covering both aggregate stock market and firm-level outcomes.

⁷ Shiller (2017, 2019) has advanced the field of narrative economics for understanding how major economic events, such as the Great Depression and the Global Financial Crisis, can be understood based on changing popular stories permeating consumption and asset markets. Mangee (2021) provides a comprehensive empirical account of narrative dynamics under instability and Knightian uncertainty for the U.S. stock market.

The last twenty years have witnessed much growth on the empirical side of macroeconomic and financial uncertainty.⁸ The empirical section of the present paper draws on uncertainty proxies developed in Mangee (2021) based on millions of unscheduled events identified across the universe of financial news reports from *Dow Jones* outlets, including *Newswire feeds*, the *Wall Street Journal*, *MarketWatch*, and *Barron's*.⁹ Financial news reports are keenly able to allow for and reflect unforeseeable change and the time-varying interpretations investors formulate in response to KU events. And, news-based uncertainty proxies have been shown to offer improved predictions of future macroeconomic and financial outcomes compared to competing measures (Karnizova and Li, 2014).

The three uncertainty proxies used here come from Mangee (2021) and are based on the frequency, proportion, and diversity of unscheduled events reported as daily drivers of the U.S. stock market from January 2000 through March 2020. The uncertainty proxies, dubbed KU, KU prop and KU var, respectively, have separate data for corporate versus macro unscheduled events. Each uncertainty proxy is compared against both aggregate and firm-level measures of forecast variance. Aggregate market forecast bounds are measured by the *Institutional Investor Newsletter* survey of bull-minus-bear percentages. Firm level forecast bounds are proxied by the dispersion of analyst longer-run earnings forecasts based on *Bloomberg* “B-est” estimates for each of the 30 firms listed in the *Dow Jones Industrial Average*.

The findings shed new light on Samuelson’s Dictum. Uncertainty across all three proxy measures leads to a narrowing of earnings forecast variance at the firm level which is consistent with the informational effect and the closer relationship between individual stock prices and fundamentals (in this case long-term growth prospects) reported in the literature. When applied to the broad market bull-minus-bear expected return spread, the count and proportion measures of

⁸ The seminal study of Bloom (2009) documents the countercyclical effects of uncertainty proxies with subsequent real macroeconomic activity. However, the author employs stock market volatility, and the second moments of other aggregates, as the main proxy for uncertainty in VAR estimates which may contribute to the short-run lag in output and employment effects. Similar results are found in Jurado *et al.* (2015) who back out an “unforecastable component of the future value” of the most-followed macroeconomic and financial series. Though the authors find that the incidence of uncertainty is less than that documented in other studies, they report the magnitude, impact, and persistence of uncertainty shocks to be greater. For a general discussion on fluctuations in macroeconomic and financial market uncertainty, see Bloom (2014) and references therein.

⁹ Baker *et al.* (2016) provide the seminal work on measuring policy uncertainty from textual analysis of economic and financial news reports. See also Frydman *et al.* (2015) for a news-based Knightian uncertainty measure tracking historical events within the context of the present value model of stock prices.

unscheduled events also share an inverse relationship with the size of forecast bounds. However, when the diversity of unscheduled events is compared to the bull-minus-bear variance, the bounds are shown to widen suggesting that the model ambiguity effect may dominate at the aggregate level. This finding holds based on correlation statistics and OLS regression estimates. Moreover, all findings are robust to whether stock market uncertainty is measured solely by corporate unscheduled events or macro unscheduled events.

The results suggest that Samuelson's Dictum may be best understood as reflecting model ambiguity at the aggregate level and informational effects at the individual level – both consequences of Knightian uncertainty. Uncertainty is the key factor in understanding Samuelson's Dictum, but only when based upon proxies which capture the diversity of interpretations investors form about novel events in the stock market.

The paper is organized as follows. Section 2 provides a sketch of Frydman *et al.* (2019)'s KUH model with particular focus on behavior of the forecasting interval bounds. Section 3 describes the data. Section 4 presents the empirical findings in relation to the premise of Samuel's Dictum while Section 5 offers concluding remarks.

II. The Model

The key feature of the KUH approach developed by Frydman *et al.* (2019) lies in the intertemporal representation of market participants' forecasts of future fundamentals, say earnings or dividends, in driving stock prices at time t .¹⁰ Consider the following intertemporal model, no-arbitrage condition, of the stock price which investors bid to,

$$p_t = \gamma(\mathcal{F}_t(d_{t+1}) + \mathcal{F}_t(p_{t+1})) \quad (1)$$

where p_t denotes the stock price, d_t denotes dividends, $\mathcal{F}_t(\cdot)$ denotes the time- t forecasts of dividends and stock prices at time $t+1$, and γ is a discount factor assumed constant.¹¹

¹⁰ This section draws on the theoretical framework of Frydman *et al.* (2019) where the reader can find the complete set of assumptions, corollaries, lemmas, and proofs.

¹¹ Consistent with Frydman *et al.* (2019), the representation in (1) assumes risk-neutrality. Unlike, Frydman *et al.* (2019), however, the forecast represented by $\mathcal{F}_t(\cdot)$ will be applied here to the individual and the market (an aggregate of its participants) for the purpose of re-envisioning Samuelson's Dictum.

KUH models recognize that all observers of financial markets — investors, policy-makers, the public, and researchers alike — face Knightian uncertainty about the processes driving outcomes. Consequently, KUH models must abandon sharp predictions based on stochastic representations of change in order to be open to unforeseeable change. The dividend process is taken to be a function of earnings, where log-earnings, denoted by x_t , are assumed to follow a random-walk with time-varying drift,

$$\Delta x_t = \mu_t + \varepsilon_{x,t} \quad (2)$$

for $t = 1, 2, \dots$, and where $\{\mu_t\}_{t=1,2,\dots}$ is a sequence of deterministic constants and $\varepsilon_{x,t}$ is independent over time with mean zero and constant variance σ_x^2 .

Probabilistic risk, as opposed to uncertainty, is captured through the conditional statistical moments governing the variance, σ_x^2 , of $\varepsilon_{x,t}$. By contrast, changes in the drift coefficient, μ_t , are constrained to lie within *ex ante* constraints reflecting the Knightian uncertainty that researchers and market participants face about the process driving firm earnings. That is, the earnings drift coefficient for any μ_{t+k} is constrained by upper and lower bounds within the intervals,

$$\mu_{t+k} \in I_{t:t+k}^\mu = [L_{t:t+k}^\mu, U_{t:t+k}^\mu] \quad (3)$$

where $[L, U]$ denote the lower and upper bounds, respectively, of the time-varying interval within which μ_{t+k} may take on any unknown value. The time-varying drift may, thus, be defined by one of a family of unknown probability distributions at every point in time — past, present, and future — within these bounds. Therefore, the representation of earnings and earnings drift from equations (1)-(3) implies that earnings at time $t+k$ follow,

$$x_{t+k} = x_t \exp \left(\sum_{j=1}^k \varepsilon_{x,t+j} \right) \exp \left(\sum_{j=1}^k \mu_{t+j} \right) \quad (4)$$

The future value of earnings, x_{t+k} , is a function of earnings at time- t , x_t , stochastic innovations assumed $N(0, \sigma_x^2)$, $\{\varepsilon_{x,t+j}\}, j = 1, 2, \dots, k$, and the family of future deterministic drift terms, $\{\mu_{t+j}\}, j = 1, 2, \dots, k$ which are allowed to vary in unforeseeable ways within the interval $I_{t:t+k}^\mu$.

This representation allows for a probabilistic representation of constraints at time- t which bound future values of earnings x_{t+k} such that,

$$x_{t+k} \in I_{t:t+k}^x = [L_{t:t+k}^x, U_{t:t+k}^x] \quad (5)$$

where the constraints of upper- and lower-bounds can be expressed as,

$$L_{t:t+k}^x = x_t \exp \left(\sum_{j=1}^k \varepsilon_{x,t+j} \right) \exp \left(\sum_{j=1}^k L_{t:t+j}^\mu \right) \quad (6)$$

$$U_{t:t+k}^x = x_t \exp \left(\sum_{j=1}^k \varepsilon_{x,t+j} \right) \exp \left(\sum_{j=1}^k U_{t:t+j}^\mu \right) \quad (7)$$

The stochastic representations governing end-points of lower- and upper-bounds provide a family of time- t conditional probability distributions for future values of earnings. Knightian uncertainty about the earnings process implies that the single distribution describing future earnings (of the many available) is unknown to all market observers. The degree of unforeseeable change allowed for in equations (6) and (7) will depend on the *ex ante* constraints imposed on the coefficient μ_{t+1} . One simple approach to setting the *ex ante* constraints on equations (6) and (7) allows for μ_{t+1} to take on any value within the interval expressed by,

$$\mu_{t+1} \in I_{t:t+1}^\mu = [L_{t:t+1}^\mu, U_{t:t+1}^\mu] = [\mu_- + \rho_\mu(\mu_t - \mu_-), \mu_+ + \rho_\mu(\mu_t - \mu_+)] \quad (8)$$

where $\mu_- < \mu_+$, $0 \leq \rho_\mu < 1$ and the initial condition is $\mu_- \leq \mu_1 \leq \mu_+$. The *ex ante* constraints in (8) allow for μ_{t+1} to change in open ways within the interval $I_{t:t+1}^\mu$ given the exogenous constant parameters μ_- , μ_+ and the autoregressive term ρ_μ . The constraints also satisfy the conditions $L_{t:t+j+1}^\mu \leq L_{t+1:t+j+1}^\mu$ and $U_{t:t+j+1}^\mu \geq U_{t+1:t+j+1}^\mu$ which imply that from the perspective of time- t , Knightian uncertainty increases (i.e. the size of the interval $I_{t:t+j}^\mu$ widens) as the time horizon j expands. The greater the time horizon is, the more opaque an investor forecast of future fundamentals and returns becomes and, consequently, the less confidence accompanying it.

The results section provides empirical evidence suggesting that whether the *ex ante* constraints bounding the interval $I_{t:t+j}^\mu$ widen or narrow for investor forecasts depends on whether ambiguity or informational effects, respectively, reinforce or contradict the uncertainty-based horizon effect. At any given time $t=j$, the model ambiguity effect leads to a widening interval $I_{t:t+j}^\mu$ of, say, earnings growth forecasts consistent with the representation in (8). However, the informational effect corresponds to a narrowing interval. Therefore, it is surmised that model ambiguity and the horizon effect are reinforcing while the informational effect and horizon effect are contradictory. If the informational effect dominates the horizon effect then $L_{t:t+j+1}^\mu \geq L_{t+1:t+j+1}^\mu$ and $U_{t:t+j+1}^\mu \leq U_{t+1:t+j+1}^\mu$

The subsequent findings suggest that model ambiguity, reinforcing the horizon effect, dominates at the aggregate market level, but that informational effects compete with, and dominate, horizon forces at the firm level resulting in a narrower earnings drift interval for firm forecasts. This is the KU explanation of Samuelson's Dictum: facing unforeseeable change, investor interpretations of macro KU events are often conflicting leading to a greater diversity of investor views about whether to take bullish versus bearish positions in stock. This leads to greater model ambiguity surrounding which forecasting strategy is best suited to understand new stock price relationships.

To relate the KUH earnings process to dividends as part of the intertemporal model of stock prices in equation (1), dividends d_t are assumed to follow a linear relation with earnings. The impact from earnings on dividends is captured by time-varying coefficients $\{b_t\}_{t=1,2,\dots}$ such that,

$$d_t = b_t x_t + \varepsilon_{d,t} \quad (9)$$

where $\varepsilon_{d,t}$ are assumed I.I.D. errors with distribution $N(0, \sigma_d^2)$. The coefficients $\{b_t\}_{t=1,2,\dots}$ are assumed to vary over time in open ways and are constrained to lie within time-varying intervals,

$$I_{t:t+k}^b = [L_{t:t+k}^b, U_{t:t+k}^b] \quad (10)$$

and where dividends d_{t+k} are assumed to follow,

$$d_{t+k} = x_t b_{t+k} \exp\left(\sum_{j=1}^k \varepsilon_{x,t+j}\right) \exp\left(\sum_{j=1}^k \mu_{t+j}\right) + \varepsilon_{d,t+k} \quad (11)$$

Analogous to the earnings representation in equation (4), future dividends, d_{t+k} , are a function of current values of earnings at time t , time-varying weights attached to earnings, the stochastic innovations in earnings, the time-varying deterministic trends in earnings and the stochastic innovations in dividends. Dividends lie within stochastically bounded intervals where,

$$d_{t+k} \in I_{t:t+k}^d = [L_{t:t+k}^d, U_{t:t+k}^d] \quad (12)$$

and the bounds of the interval follow,

$$L_{t:t+k}^d = x_t L_{t:t+k}^b \exp\left(\sum_{j=1}^k \varepsilon_{x,t+j}\right) \exp\left(\sum_{j=1}^k L_{t:t+j}^\mu\right) + \varepsilon_{d,t+k} \quad (13)$$

$$U_{t:t+k}^d = x_t U_{t:t+k}^b \exp\left(\sum_{j=1}^k \varepsilon_{x,t+j}\right) \exp\left(\sum_{j=1}^k U_{t:t+j}^\mu\right) + \varepsilon_{d,t+k} \quad (14)$$

where the end-points of the interval within which dividends lie are represented by stochastic distributions based on the residual innovations $\{\varepsilon_{d,t+k}\}_{j=1,2,\dots}$ given the parameter time- t values for μ_t and b_t . The *ex ante* constraints researchers impose on the interval governing dividend's $t+1$ coefficient on earnings, b_{t+1} , imply that,

$$b_{t+1} \in I_{t:t+1}^b = [L_{t:t+1}^b, U_{t:t+1}^b] = [b_- + \rho_b(b_t - b_-), b_+ + \rho_b(b_t - b_+)] \quad (15)$$

where $b_- < b_+$, $0 \leq \rho_b < 1$ and the initial condition is $b_- \leq b_1 \leq b_+$. Analogous to equation (8), future dividends for any $j \geq 1$, $b_{t+j} \in I_{t:t+j}^b = [L_{t:t+j}^b, U_{t:t+j}^b]$ such that $L_{t:t+j}^b = b_- + \rho_b^j(b_t - b_-)$ and $U_{t:t+j}^b = b_+ + \rho_b^j(b_t - b_+)$. Imposing the horizon effect of Knightian uncertainty yields,

$$L_{t:t+j+1}^b \leq L_{t+1:t+j+1}^b \text{ and } U_{t:t+j+1}^b \geq U_{t+1:t+j+1}^b \quad (16)$$

where $b_+ > b_-$ and $0 \leq \rho_b^j < 1$. Earnings have a positive impact on dividends as long as $b_- > 0$. The representation of Knightian uncertainty surrounding the dividends process allows for a family of distributions to potentially describe future dividends d_{t+k} . Even though only one conditional distribution will prevail at each future point in time $t+k$, it is unknown to all observers at time t . The formulation of Knightian uncertainty dividend expectations, KE , within the interval conditional on x_t , given the values of μ_t and b_t yield,

$$KE_t(d_{t+k}) = [E_t(L_{t:t+k}^d), E_t(U_{t:t+k}^d)] \quad (17)$$

where taking the expectation of the upper- and lower-bounds in (13) and (14) implies an interval within which a time- t prediction of dividends at $t+k$ is expected to lie within,

$$KE_t(d_{t+k}) = x_t v^k [l_{t:t+k}^d, u_{t:t+k}^d] \quad (18)$$

where $v = E_t \exp(\varepsilon_{x,t})$ and

$$l_{t:t+k}^d = (b_- + \rho_b^k(b_t - b_-)) \exp\left(\sum_{j=1}^k (\mu_- + \rho_\mu^j(\mu_t - \mu_-))\right) \quad (19)$$

$$u_{t:t+k}^d = (b_+ + \rho_b^k(b_t - b_+)) \exp\left(\sum_{j=1}^k (\mu_+ + \rho_\mu^j(\mu_t - \mu_+))\right) \quad (19)$$

Similar to the constraints on earnings intervals mentioned above, reinforcing and competing forces, respectively, from Knightian uncertainty on interval length imply $l_{t:t+j+1}^d \leq l_{t+1:t+j+1}^d$ and $u_{t:t+j+1}^d \geq u_{t+1:t+j+1}^\mu$ for model ambiguity and horizon effects and $l_{t:t+j+1}^d \geq l_{t+1:t+j+1}^d$ and $u_{t:t+j+1}^d \leq u_{t+1:t+j+1}^d$ for informational effects.¹² The next section describes the data used to confront these implications of Knightian uncertainty on forecasting bounds at the aggregate versus firm level.

¹² The horizon effect is present at both the firm and aggregate levels and, therefore, is assumed of secondary importance for the present study's central hypotheses. However, horizon effects are presumed larger for aggregate than for firm level outcomes. As such, it is assumed that the ambiguity effect widens forecast bounds while the informational effect narrows the bounds.

III. Data

Confronting the KUH hypothesis that ambiguity and informational effects, respectively, may reinforce and contradict the horizon effect requires data on market uncertainty.¹³ Moreover, to couch the empirical methodology within the context of Samuelson's Dictum requires data on both aggregate and firm-level expectations and outcomes. Forecast bounds for aggregate stock market expectations are proxied by survey results from *the Investors Intelligence Newsletter* (IIN) produced by the *American Association of Individual Investors* (AAII). The AAI survey has a longstanding history as one of the most expansive to cover aggregate equity market expectations (Greenwood and Shleifer, 2014). The survey records the percentage of its participants' bullish, neutral, and bearish forecasts for the U.S. stock market on a weekly basis. The aggregate market forecast bounds are proxied by the bull-minus-bear spread.

Alternatively, the bounds of firm-level expectations are proxied by the variance of *Bloomberg* "B-est" analyst forecasts for longer-term growth (LTG) of earnings per share for the firms comprising the *Dow Jones Industrial Average*.¹⁴ Both aggregate and firm-level forecast spread is calculated as the standard deviation of a six-month rolling window of this corresponding data series.

This study adopts the proxy categories for Knightian uncertainty based on the novel dataset from Mangee (2021) which uses news analytics from *RavenPack* to identify all unscheduled corporate (micro) and macro events reported as driving daily firm share prices across the universe of *Dow Jones* reports including *Newswire feeds*, the *Wall Street Journal*, *MarketWatch* and *Barron's*. Unscheduled events proxy for Knightian uncertainty since they are non-repetitive and associated with unforeseeable change in price relationships. Unscheduled events at the corporate level may include CEO turnover, product recalls, debt restructuring, bankruptcy, facility closure, legal issues, industrial accidents, IPOs, M&A announcements, labor strikes and so on.

¹³ This section draws on the empirical framework of Mangee (2021).

¹⁴ *Bloomberg L.P.* has growth forecast data for over 15,000 companies worldwide. Approximately 15-25 *Bloomberg L.P.* analysts provide estimates of longer-term (greater than one-year) earnings per share for each of the 30 DJIA firms. Data was unavailable for the within-period standard deviation of LTG estimates across analysts.

Unscheduled events at the macro level may include armed conflicts, presidential elections, changes to fiscal or monetary policy, pandemics, natural disasters and so on.

Three KU proxies for each realm of corporate and macro events are applied to the present analysis. The KU Index tracks the number of monthly unscheduled events. The KU var Index tracks the number of different KU groups per month while the KU prop Index tracks unscheduled events as a proportion of total events.¹⁵ All data are at the monthly frequency for the period January 2000 through March 2020.

IV. Results

The first stage of analysis considers results at the firm level. Recall, the theoretical model in Section 2 posits that the model ambiguity effect leads to wider forecast bounds of future outcomes (returns or earnings growth) while informational effects lead to narrower forecast bounds. The Knightian uncertainty explanation of Samuelson's Dictum predicts that informational effects dominate at the firm level, but that ambiguity effects dominate at the aggregate market level.

Table 1 reports simple Spearman rank-order correlation tests between the 6-month rolling standard deviation of LTG EPS growth forecasts for individual DJIA firms and the KU Index, KU Event Variation Index, and KU Proportion Index for corporate unscheduled events.¹⁶ First, there is statistical evidence that the variance of analyst forecasts of firm-level LTG is connected to novel corporate events. Of the 30 firms, the baseline KU Index shares significant correlations with 20 of them, the KU Variation Index shares 15 significant correlations and the KU Proportion Index shares 13. Of those 48 significant correlations, 43 are significant at the 1% or 5% level, the other five at the 10% level. Second, the sign of the correlation coefficient for significant firms is

¹⁵ There are 51 groups of KU events across broad topics of Business, Economy, Environment, Politics and Society. Many of the corporate KU events fall into groups within Business. Such groups include: acquisition-mergers, analyst ratings, assets, bankruptcy, commodity prices, credit, credit ratings, dividends, earnings, equity actions, exploration, indexes, industrial accidents, insider trading, investor relations, labor issues, marketing, order imbalances, partnerships, price targets, products-services, regulatory, revenues, stock prices, and technical analysis. Many unscheduled macro events come from the groups Environment, Politics and Society. See Mangee (2021) for details.

¹⁶ Spearman correlation tests are non-parametric and help to deal with potential unit roots and issues associated with multicollinearity and nonlinearities in the data. For brevity, the macro unscheduled events are excluded from the table, but the results are consistent with those at the corporate level.

predominantly negative implying that the EPS forecast bounds become narrower when there is greater uncertainty at the firm level. In fact, 33 out of the 48 total significant correlation pairings

Table 1- Correlation Between KU and LTG Forecast Variance

Ticker	KU	KU var	KU prop	Ticker	KU	KU var	KU prop
AAPL	.062 (.414)	-.217 (.004)	.005 (.949)	KO	-.110 (.154)	-.028 (.715)	-.065 (.405)
AXP	-.222 (.003)	.210 (.006)	-.190 (.012)	MCD	.192 (.012)	-.040 (.597)	.074 (.330)
BA	-.257 (.001)	.399 (.000)	-.243 (.002)	MMM	.095 (.214)	-.079 (.306)	.030 (.693)
CAT	-.231 (.003)	.187 (.015)	-.228 (.003)	MRK	-.182 (.016)	-.001 (.984)	-.141 (.062)
CSCO	-.238 (.002)	.050 (.516)	-.065 (.400)	MSFT	-.021 (.784)	-.352 (.000)	.042 (.582)
CVX	-.261 (.001)	.153 (.044)	-.190 (.012)	NKE	-.251 (.001)	-.288 (.000)	.064 (.406)
DD	.138 (.500)	.089 (.667)	-.080 (.699)	PFE	.235 (.002)	-.003 (.968)	.020 (.797)
DIS	-.263 (.001)	.111 (.150)	-.099 (.200)	PG	.428 (.000)	-.322 (.000)	.180 (.019)
GE	-.443 (.000)	.075 (.324)	-.164 (.031)	TRV	-.439 (.000)	.424 (.000)	-.329 (.000)
GS	.253 (.004)	-.208 (.019)	.032 (.723)	UNH	.096 (.205)	.061 (.421)	-.043 (.574)
HD	-.120 (.115)	-.025 (.743)	-.025 (.743)	UTX	.137 (.070)	-.040 (.595)	-.057 (.448)
IBM	-.269 (.000)	-.014 (.853)	-.142 (.062)	V	-.334 (.000)	.001 (.994)	-.147 (.084)
INTC	.061 (.425)	-.227 (.003)	.050 (.513)	VZ	.171 (.026)	-.071 (.359)	-.022 (.779)
JNJ	-.195 (.011)	.369 (.000)	-.255 (.001)	WMT	.061 (.424)	-.315 (.000)	.133 (.079)
JPM	.035 (.649)	-.390 (.000)	.147 (.056)	XOM	-.152 (.047)	-.224 (.003)	-.028 (.719)

Source: Manglee (2021)

P-values are reported in parentheses. Bold values indicate statistical significance at the 1%, 5%, or 10% level.

Notes: The table reports Spearman correlation coefficients between the 6-month rolling standard deviation of *Bloomberg* analyst estimates of long-term growth (LTG) in earnings per share for the 30 firms listed on the DJIA over the sample period January 2000 through March 2020. Not all B-est LTG firm data go back to January 2000, but all series contain at least 150 observations.

(roughly two-thirds) are negative across all three proxies of Knightian uncertainty. The findings suggest that informational effects from unscheduled events are driving a closer connection between fundamentals and stock prices at the firm level.

Table 2 reports the correlation tests at the aggregate level between the bull-minus-bear market spread and the KU indices across both corporate and macro unscheduled events. The first

main finding in the aggregate data is that when uncertainty is higher, both in count of KU events and as a proportion of total events, the variance of the bull-minus-bear expectations is lower. This result is statistically significant and holds for uncertainty proxies at both the corporate and macro level. At first glance, this would seem to suggest that the information effect from uncertainty-laden events dominates the horizon and ambiguity effects at the aggregate level. However, the second main finding in the aggregate data is that when the diversity of uncertainty event groups, as proxied by KU var, increases, the variance of bull-minus-bear expectations also increases. This finding is significant and holds for corporate and macro uncertainty event groupings. That is, when there are more different groups of unscheduled events, the forecast bounds widen suggesting that model ambiguity dominates the informational effect when KU event group diversity is accounted for.

Table 2 – Correlation Between KU and Market Forecast Variance

	KU	KU var	KU prop	KU macro	KU macro var	KU macro prop
$\sigma^{bull-bear}$	-.455 (.000)	.256 (.000)	-.276 (.000)	-.444 (.000)	.385 (.000)	-.216 (.000)

Notes: The table reports Spearman rank-order correlation coefficients between KU indices and the 6-month rolling standard deviation of bull-minus-bear spread from the American Association of Individual Investors survey; p-values for the null hypothesis that both variables share a zero correlation are reported in parentheses. KU variables are based on Mangee (2021) and described in the text.

This second main finding is consistent with the view that uncertainty shocks at the aggregate level introduce too much noise and, likely, contradictory forecast assessments for broad market returns to clearly reflect a consistent directional impact. To extend the empirics, Table 3 presents OLS estimates from regressing the KU proxies on the rolling standard deviation of aggregate bull-bear spread.¹⁷ Consistent with the correlation results from Table 2, the OLS estimates report negative and significant uncertainty coefficients based on KU and KU prop proxies. However, when uncertainty is measured by KU var, the coefficients become positive and significant.

How can the predominantly negative relations between KU var and firm level forecast bounds be reconciled with the positive relations between KU var and aggregate forecast bounds? Put differently, how might the informational effect manifest itself at the firm level when KU var

¹⁷ Reported p-values are based on heteroskedasticity and autocorrelation consistent (HAC) standard errors.

increases? For instance, if KU var increases because the groups Analyst Ratings, Credit Ratings, Credit and Equity Actions all contain categories of unscheduled firm events which are interpreted

Table 3 – OLS Estimates of Uncertainty on Market Forecast Variance

$\sigma^{\text{bull-bear}}$	KU	KU var	KU prop	KU macro	KU macro var	KU macro prop
β	-.000 (.000)	.005 (.011)	-.095 (.000)	-.000 (.000)	.006 (.000)	-.108 (.082)
R ²	.24	.06	.08	.22	.12	.03

Notes: The table reports OLS estimates from regressing KU indices on the 6-month rolling standard deviation of bull-minus-bear spread from the *American Association of Individual Investors* survey; p-values are reported in parentheses based on heteroskedasticity and autocorrelated consistent (HAC) standard errors; KU variables are based on Manglee (2021) and described in the text.

as bearish overall for a particular firm's cash flow prospects, then the increase in KU var would lead to a reduction in the variance of analyst projections of long-run earnings growth. The bounds would be narrowed due to the similar qualitative interpretations of unscheduled news' impacts. Narrative links which connect the qualitative interpretations across groups of historic events would then serve to shape and clarify the overall degree of bearishness versus bullishness of the firm's relevant information set.

By contrast, the unscheduled events potentially relevant for the broad market are more likely to possess conflicting interpretations for investors' return forecasts. Consider, for instance, how an investor might weigh the net prospects from, on the one hand, bearish interpretations of a pandemic, recession, and sky-rocketing unemployment with, on the other hand, bullish interpretations of historic stimulus, accommodating monetary policy, technological innovation, and an election outcome which maintains corporate-friendly tax cuts.

Of course, this example from major macro events of 2020 is simplified, but apt for understanding the role of Knightian uncertainty in explaining Samuelson's Dictum for the stock market. The lack of a connection between aggregate stock market prices and fundamentals is due to ambiguity effects — the macro noise shocks obfuscate views into the future. The closer connection between firm prices and fundamentals is due to the informational effect. The key to discerning these effects lies in the ability to assess different dynamics of unforeseeable change due to unscheduled events and the uncertainty they engender. To be sure, these findings, which extend and complement those of Manglee (2021), are suggestive. Further research is warranted to shed more light on this re-interpretation of Samuelson's Dictum through the lens of Knightian

uncertainty. Taken together, however, these results offer new views on the large literature documenting that expected returns and varying discount factors explain the largest proportion of variation in stock returns at the aggregate level; whereas, cash flow effects appear to be the primary driver of stock returns at the firm level.

V. Conclusion

Samuelson's Dictum asserts that the efficient markets hypothesis holds better for individual stocks than for the broad market. That is, information on theory-implied fundamentals, such as dividends or earnings, is better reflected in firm stock prices than in aggregate indices such as the *Standard & Poor's 500*, *NASDAQ* or *Dow Jones Industrial Average 30*. The explanation in the mainstream literature contends that aggregate prices become disconnected from fundamentals due to time-varying risk premia or waves of investor sentiment and momentum trading. By contrast, firm prices better reflect fundamentals as investors, benefited by volumes of financial disclosures and targeted events, can more easily identify the corporate activities and news which position a stock's price as currently over or undervalued in the industry.

This study offers an alternative view of Samuelson's Dictum, namely, that unscheduled events cause instability and Knightian uncertainty which manifests itself for stock prices in different ways at the aggregate versus firm level. The key factor for the KU explanation of Samuelson's Dictum lies in the size of the forecasting interval of future returns or earnings/dividends. If the horizon or model ambiguity effects from uncertainty dominate, then the forecast bounds widen; if the informational effect from uncertainty dominates, the forecast bounds become narrower. This view is motivated by the theoretical framework of Frydman *et al.* (2019) who develop the Knightian Uncertainty Hypothesis (KUH). Under KUH, explanatory variables, investor forecasts and market outcomes are allowed to unfold in open ways, to be determined by one of a family of unknown distributions within intervals constrained by stochastically determined bounds.

Data on Knightian uncertainty come from Mangee (2021) which tracks unscheduled events identified by the *RavenPack* News Analytics platform across the universe of *Dow Jones & Co.* financial news outlets over the last two decades. The variance of aggregate forecast bounds for

returns is proxied by the *Institutional Investor Newsletter* bull-minus-bear spread while that of firm level earnings forecasts is proxied by *Bloomberg* “B-est” long-term growth data.

Simple non-parametric correlation tests find that Knightian uncertainty proxies share a significant inverse relationship with the variance of EPS forecast bounds for individual DJIA 30 firms suggesting that the informational effect dominates at the firm level. This finding holds when uncertainty is based on the count of unscheduled events, their proportion of total events and the number of different unscheduled event groups. When applied to the aggregate bull-minus-bear spread, the correlation is also negative, but only for count- and proportion-based uncertainty proxies. When uncertainty is based on the number of different unscheduled event groups (i.e. event group diversity), the correlation becomes positive and significant at the aggregate level, even though group variation displayed a significant negative sign at the firm level. Results from univariate OLS regressions support the positive and significant relationship between unscheduled event-group diversity and the spread of aggregate forecasting bounds.

These unsurprising findings suggests that one key, and overlooked, factor in explaining Samuelson’s Dictum for the stock market is the dynamic role of Knightian uncertainty which impacts aggregate markets differently than individual stocks. Macro uncertainty shocks obfuscate an overall “bullish” versus “bearish” directional forecast of future returns for broad indices. Their effects, however, spillover onto future unscheduled corporate events which offer an enhanced information set for assessing relative valuations of firm stock prices. Specifically, it is the diversity of (likely contradictory) unscheduled events for participants’ forecasts which diminishes the clarity of forecasting confidence, producing wider forecast bounds, at the aggregate market level. By contrast, unscheduled events play a more informational role, shaping directionally consistent views, and leading to narrower forecast bounds at the firm level. Future research is warranted to investigate further the role of Knightian uncertainty in understanding market efficiency. Other studies may wish to explore the ability of different uncertainty proxies to offer alternative explanations of extant anomalous findings by relaxing the assumption that change in asset market relationships can be represented based on probabilistic rules.

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